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SOME IRRIGATION AND DRAINAGE PROBLEMS OF MEDITERRANEAN AND MIDDLE EAST COUNTRIES

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SOME IRRIGATION AND DRAINAGE PROBLEMS OF MEDITERRANEAN AND MIDDLE EAST COUNTRIES

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SYNOPSIS

Some brief comments are made concerning the water resources and their development in Yugoslavia, Libya, Israel, Turkey, Syria, Iraq, Pakistan, and India.

Yugoslavia, a country of approximately 100,000 square miles and 16,000,000 people, needs to increase its food production. Water and land resources are inadequately developed. Expansion of irrigation and improvement of drainage conditions will help to accomplish this objective.

Although Libya possesses an area about one fourth that of the United States, its water resources are so limited that there is little opportunity to greatly expand its very limited irrigated acreage. Improvement in live stock and range offer greater promise than does irrigation.

Israel is working on the problem of transporting water from the northern part of the country to the southern arid section so that it can increase its food production.

Turkey is actively planning the development of her water resources. Her cooperation will be required if the full resources of the Tigris and Euphrates Rivers are to be developed in Syria and Iraq, where the potential for irrigation expansion is great. In this development, drainage is a very necessary corollary of irrigation.

The great Indus Valley of Pakistan besides being deficient in water during certain periods of the year is plagued with high ground water and salinity problems. Some adequate solution to these problems must be found if the valley's great food producing potential is to be maintained.

India, which in the northern part depends upon stream diversion for irrigation, and on tank storage in the southern half, has an irrigated acreage estimated at 50,000,000 acres. This area is being expanded and the water supply firmed through the construction of such major projects as the Damodar Valley and the Bhakra - Nangal projects.

Within the period August 1, 1951 to June 30, 1952, I had the opportunity to study irrigation and drainage problems in the following countries: Yugoslavia, Libya, Syria, Iraq, Pakistan, India, Turkey, and Israel.

Yugoslavia

The trip to Yugoslavia was made by train in late August via Trieste, Ljubljana, and Zagres to Belgrade. From Belgrade the travel was by jeep and car. All arrangements for transportation within the country were made by the Yugoslavian government. Professor Vladisarlievic of the Engineering College

of the University of Belgrade was my interpreter and he and Engineer Nescovic, Head of the National Division of Reclamation, accompanied me on my motor travels throughout the country.

Yugoslavia has an area of approximately 96,000 square miles, much of which is mountainous, including the Julian Alps in the northwest and the Dinaric range, a karstic formation extending parallel to the Adriatic Sea from Italy to Albania. The principal agricultural area lies in the flood plain of the Danube River basin in the northeastern part of the country. Important tributaries of the Danube River in Yugoslavia include the Tisa, Drava, Sava, and Morava.

Climate of the country is influenced greatly by topography. Part of the Adriatic sea coast has a semi tropical climate, that of the mountainous area is alpine, while the Danube Valley proper has a climate not unlike western Europe. Precipitation as high as 12 feet per annum has been measured in parts of the Dinaric range.

Yugoslavia's population is about 16,000,000 with the greatest density in the Vojvadina area north of Belgrade.

Flow records of the important streams are available for the period 1925 to 1940, and from 1947 to date. At Nova Sad, north of Belgrade, additional information on suspended matter and chemical composition is being obtained. The amount of total dissolved solids is low, varying from 130 to 320 parts per million. Average annual measured flow of the Danube as it enters Yugoslavia is about 55 million (68,000 million cubic meters) acre feet, as it leaves the country, 142,000,000 acre feet. The Tisa and Drava rivers import 19,500,000 and 8,000,000 acre feet respectively. They later join the Danube within the country with flows of 40,000,000 and 16,000,000 acre feet.

The Danube, an international stream draining parts of eight countries, enters Yugoslavia on a very flat gradient. The only practical solution for controlling floods is by levees, of which there are some 800 miles. These levees were built by hand, beginning about 1790. An engineer who was in charge of the construction of a section of the levee system just prior to the First World War said that 20 cubic meters, (about 26 cu. yds) of earth loaded into a wagon was considered a normal day's work for a man. A rigid levee patrol system is maintained. Additional drainage systems have been planned, the largest being along the Sava east of Zagreb.

The great basin of low lying land in Vojvadina was partially drained during the time the region was a part of Hungary. Water from the drains is delivered into the river system by pumping plants, most of which were installed prior to the First World War. Of the more than one hundred plants pumping in the system, only four were electrically operated in 1951.

Concomitant with the inability to maintain desirable drainage conditions in the basin has been the loss of agriculture land because of high water table and alkali. This condition is of great concern to the country, and an effort has been made to obtain outside assistance in the rehabilitation and improvement of the system.

Irrigation: Although there is little irrigation in the country at present (probably not more than 40,000 acres) it is clearly recognized that in certain years when the rainfall is low or poorly distributed marked improvement in crop production can be attained through irrigation. An irrigation experimental field station has been established at Skbabran, Serbia, where studies are being made of the crop responses to irrigation, and the cost of supplemental irrigation. Because the amount of irrigation water required per unit area is not large, and because the land has generally not been levelled for irrigation,

sprinkler irrigation is strongly favored. It is said that just prior to Yugoslavia's decision to withdraw from the Russian orbit that a large order for sprinkler equipment, entailing a big deposit, had been placed with Czechoslovakia. Unfortunately the order was never filled.

A plan for a large multipurpose irrigation, transportation, and power project has been proposed for northern Serbia. The plan provides for the enlargement of the canal which joins the Danube with the Tisa River, making irrigation an important phase of the project. This was one of the projects for which Yugoslavia was attempting to obtain outside assistance.

Projects of varying magnitude are being considered for development in other regions; including the further development of a sub-tropical fruit industry along the Dalmation coast. The drought of 1950 demonstrated the need for a more dependable food supply. Cereal grains, legumes, sugar beets, hemp, and sunflower are important crops in this country. Plums are an important fruit crop, much of which is used in making brandy.

Expansion of hydroelectric power is being strongly pressed. Good reservoir sites are scarce in the Dinaric Mountain range because of the rough terrane and the highly permeable rock.

Yugoslavia, especially in the state of Serbia, has a large number of professionally trained personnel. Student enrollment in technical schools and universities was in 1951-52 at an all time high. It was said that there were 6500 students in the engineering colleges of the University of Belgrade, of which 1500 were in civil engineering. At the University of Zagreb the number of civil engineering graduates is about 25.

The older members of the University faculties have, as a rule, studied outside the country, but this is not generally true of the younger members.

Library and laboratory facilities are very limited, having been depleted by the war.

Libya

Libya, with an area of approximately one fourth the United States of America became an independent kingdom at the beginning of 1952. It includes the states of Tripolitania, Cyrenaica, and Fezzan. The first two units border the Mediterranean Sea, while the latter is in the interior. The total population, mainly arab, does not exceed 1,200,000.

Spreading of occasional runoff waters from wadi channels, and storage of surface waters in cisterns were practice in this region by the Romans. The arab, being largely nomadic, neglected the elaborate water storage systems of the Romans, mainly being content to rely on wells sufficient to supply domestic and stock needs. In the coastal area where ground water could be found at shallow depth, small irrigated farms were developed through the use of a draft animal powered pumping unit known as a dalu. The dalu is a long spouted leather bucket which empties automatically upon reaching the ground surface.

Prior to World War II, the country was part of the Italian Empire, and large sums of money and much effort were expended to develop the agriculture of the region. This program was largely based upon the development of the ground water resources. Through extensive exploration the Italians discovered two deeper aquifers. Water from the second aquifer was normally developed by digging a well to the first water bearing formation, and then, by drilling, tap the second. The common method of pumping these wells was to place a centrifugal pump at the bottom of the dug well. The third water bearing

formation was tapped in the limestone formation sometimes at a depth of 1800'. These were normally flowing wells, some under static heads of 230 feet. Well clogging through chemical deposition is usually excessive causing great reduction in flow.

Springs are not uncommon in the Karstic formations of Cyrensica, but with the exception of the large spring at Tauorga, and a number of minor ones along fault lines, they are rather limited in Tripolitonia. The spring at Tauorga is very large and is said to have a flow of 6000 liters per second, about 200 cfs.

Much has been said about the development of water for irrigation in Libya, but in my opinion, most of these outlooks are too optomistic. The surface waters could be better utilized, but they offer no hope for great expansion. Ground waters in the shallow aquifers are being overdeveloped in some areas while further potential expansion into new areas is not great. Waters from most of the 88 deep wells that have been drilled in Tripolitania are highly saline so that only plants with fairly high salt tolerance can be grown.

Libya is largely dependent upon livestock. Since the country cannot rely upon great expansion of irrigation, improvement, if it is to come, must be largely through betterment of range and livestock conditions.

Turkey

The present irrigated acreage of Turkey is about 275,000, divided about equally between government and private systems. Much can be done to expand the irrigated area. The Turkish government, with MSA aid, is carrying on an active program of water resource surveys, planning, and development. Two American engineering firms, Knappen-Tippett-Abbott, and the International Engineering Company have been employed to study the development of at least four drainage basins.

Study of the water resources and plans for their development are the responsibility of the Elektrik Isleri Etud Idaresi (Electrical Research Administration). When a plan has been approved, it becomes the responsibility of the Department of Hydraulic works to construct and operate the system.

Syria

Irrigation is an old practice in Syria, yet much can be done to develop the water resources and improve irrigation. Development of ground water resources, by tunelling into alluvial fans, to provide gravity flow from the ground water has long been a common practice in certain areas. The surface waters have been utilized through diversion and water wheel lifting for a long period of time. The Romans built a major dam on the Orontas River which now serves as a part of a modern structure built by the French during their recent occupation.

While most of Syria has an annual rainfall less than 8 inches, precipitation in the Lebonese mountains reaches 60 inches, and for the Orontas valley from 15 to 25 inches.

In the Hauran district in the southwestern part of the country, producing wells, mainly for domestic use, are being developed in basalt. Large springs are found in this basaltic area where underlying impervious marls cause the flow of water to the surface. Some 7500 acres are irrigated by springwater in this part of Syria.

The water resources of the Euphrates River basin in northeastern Syria are yet to be developed. There, full development will depend in large measure

upon a satisfactory working agreement with neighbor countries.

Israel

The water problems of the gerrymandered State of Israel are in large measure related to the poor distribution between land and water resources. The surplus waters are in the upper north eastern part of the country, while the large areas of undeveloped lands lie in the south. Favorable ground water conditions prevail in the central coastal regions but as yet these resources have not been fully developed. Rather, the general plan is to develop first the lands along the perimeter of the country.

Irrigation by sprinkling is very popular in Israel. This method has been used in places where a better job would have been obtained more economically by other methods. The raising of fish in artificial ponds has been very productive of food on an area basis, but not from a water use standpoint. Water uses in excess of 20 acre feet per acre have been noted. This practice results in high ground water and salty land.

The great need for food cause the development of projects, which under conditions of less demand, would not be considered feasible.

Iraq

The country of Iraq contains the valley of the Tigris and Euphrates Rivers, the land of Mesopotamia. Here in this arid climate irrigation was practiced on a large scale some 5000 years ago. And, here also was developed the first system of laws, the Hamurabian Code. Much of this code was concerned with the ownership and use of waters.

The Euphrates River rises in Turkey and flows through parts of Syria into Iraq. It joins the Tigris River below Baghdad and then flows into the Persian Gulf. The mean annual flow (1918-48) at Hit, near Baghdad, was 20,600,000 acre feet, the maximum flow 177,000 cfs. There are no storage reservoirs of any consequence on this stream, so during flood period the waters overflow into an old lake bed west of Baghdad.

The Tigris River rises in Turkey and Iran and flows into and through Iraq. It is a larger stream than the Euphrates, the mean flow during the 30 year period listed above was 34,300,000 acre feet. The city of Baghdad is rimmed with levees to protect against flood.

During 1948, Dr. Frank M. Eaton made a study of the quality of water in these two rivers and found it to be of good quality. The nature of the dissolved salts were such as not to produce a carbonate soil. Drainage, however, is a very necessary operation, as much of the basin is plagued with a high water table.

The irrigated area of Iraq is estimated to be slightly in excess of 6 million acres, of which half is irrigated in any one year. Mr. Sevian, Inspector General of Irrigation, states that about half the irrigating is done by diversion, the remainder by low lift pumping. He estimates the cultivable land area of the two basins at 35,000,000 acres.

Full development of the water resources of these two important streams will require the cooperation of the neighboring countries, for some of the good reservoir and power sites lie outside Iraq, while most of the potential irrigable land is within its borders. The government of Iraq, recognizing the importance of developing its water resources for irrigation, power, and transportation, has created a central board to study and plan the development. Planning assistance is also being given by outside agencies.

Pakistan

Pakistan, which became an independent nation in 1947, is divided into two parts, East and West, separated from each other by nearly 1000 miles. The total area is 364,000 square miles, the population 76,000,000 of which some 56%is in East Pakistan where the average population density is estimated at 870 per square mile.

Agriculture constitutes the main source of wealth, with jute, rice, cotton, and wheat being the principal crops.

The agricultural area of West Pakistan lies in the great basin of the Indus River and its tributaries. The agriculture of East Pakistan is confined to the flood plain of the Ganges and Brahmaputra Rivers. During the monsoon period, which usually lasts from June to October, the flood plain is covered with water to a depth up to 20 feet. Rice is grown in the flood water, and is often harvested in boats. Food production could be increased by irrigation during the dry season.

Irrigation of Western Pakistan was developed by the English during their regime. The irrigation system is very large and extensive. One main canal is in excess of 200 miles in length and has a capacity in its upper reaches of 15,000 cfs. As the Indus carries a large amount of silt during flood stage, the canals are designed to carry the silt to the land.

The great problem confronting the Indus Valley is the large loss of agricultural land caused by high water and alkali. This annual loss of cultivated land is estimated to be from 25,000 to 30,000 acres. Various proposals for the reclamation of this area has been made, but, as yet, no unanimity of opinion exist as to the best method to follow. Pumping from deep wells is expensive and the quality of ground water varies widely in quality.

The Lower Sind Project, which will develop some 2,000,000 acres in southwestern Pakistan, is nearing completion. It will be very necessary to develop drainage facilities in the early stages of this project, as much of the land is saline and the elevation above the sea is generally less than 50 feet.

The Thal project of 1,800,000 acres is another projec. recently developed. A 30 mile canal, with a capacity of 10,000 cfs diverts water from the Indus River at the Kinnah Barrage. The Pakistan government is settling these 15 acre unit farms with people divided according to tribal lines. Average cost of the land to the settler is $40 per acre with no payments during the first two years. The Colombo Plan (a British Empire Organization) has given financial aid to this program.

The state of Punjab maintains a laboratory at Lahore for hydraulic model testing and research on engineering materials. The state also maintains a 3000 acre farm for the investigation of drainage and salinity control practices.

In summary, the big problems confronting Pakistan are: finding an economically feasible solution to the reclamation of water logged and saline lands of West Pakistan, lack of reservoir sites for the storage of flood waters of the Indus River, and, extension of irrigation in East Pakistan.

India

India is a land of extremes, both socially and physically. Rainfall varies from as much as 460 inches per annum in the northeast to as low as 3 inches in the northwest. The population of about 350 million is increasing at a rate of about 3 million per year. The total area of the country is about 780 million acres, of which nearly half is classed as cultivable. This latter figure is probably high.

There are about 49,000,000 acres within the irrigation systems of India. In the southern part of the country, irrigation through the use of water stored in shallow surface reservoirs (tanks), has long been practiced. During the British regime, irrigation by stream diversion was developed, mainly in the northern part of the country. Diversion of natural flow has about reached its limit, so storage of flood waters is now receiving attention. It is estimated that less than 6%of the total runoff of 1,350,000,000 acre feet is used at the present time. With minor exceptions, there has been no legislation in India in the law of water rights.

Present power development is about 500,000 kw out of a potential of forty millions.

In 1945 the Indian government created "The Central Water-Power, Irrigation and Navigation Commission". Headquarters are at New Delhi, with the Research Station at Poona, near Bombay. The commission has some 25 projects under investigation. Where the provinces are relatively strong, they have not relied upon the central government to develop the projects, but this is not so for the less strong states.

Among the large multipurpose projects under construction are:

A - Bhakra - Nangal dams on the Sutlej, a tributary of the Indus River in Punjab. The dam is to be a straight gravity type concrete structure 680 feet high and 1650 feet long. The reservoir will have a gross storage of 7,200,000 acre feet. Stored water will be used to generate power and to irrigate 6,600,000 acres.

B - Damodar Valley Project in West Bengal, patterned after TVA, is nearing completion. About a million acres of new lands will be brought under irrigation in this project.

It is estimated that the projects now under construction plus those that are to be started in the near future will increase the irrigated area about 42,000,000 acres, and the power supply by 11 million kw.

The deep well pumping project in United provinces has received considerable attention in the American press. This project is being financed in part by Point 4 funds.

Like Western Pakistan, large areas in the flood plain of the Ganges are being lost because of alkali. It is a clear example of the need to consider the composition of the dissolved salines as well as their total content. Waters with a high sodium percentage, or with a potential for causing a high sodium percentage in the soil solution, normally lead to the production of an alkali soil.

Americans can learn much regarding the premature reclamation of delta areas by marginal embankments along tidal channels. The Bengal River Research Institute has been studying the Gangetic Delta east of Calcutta. Confinement of the river channel has caused the bed of the river to rise above the surrounding land, thus making the cost of drainage prohibitive. The areas reclaimed under these conditions must eventually revert to waste lands.

In discussing Indian water resources and their development, mention should be made of the numerous engineering organizations and research institutes in the country. Some very large engineering works are now under construction. While the major engineering aspects of irrigation have received a great deal of attention, efficient water use on the farm has not received the attention it deserves. Poor land preparation, excessive water application, and inadequate drainage has resulted in large acreages being lost to cultivation.

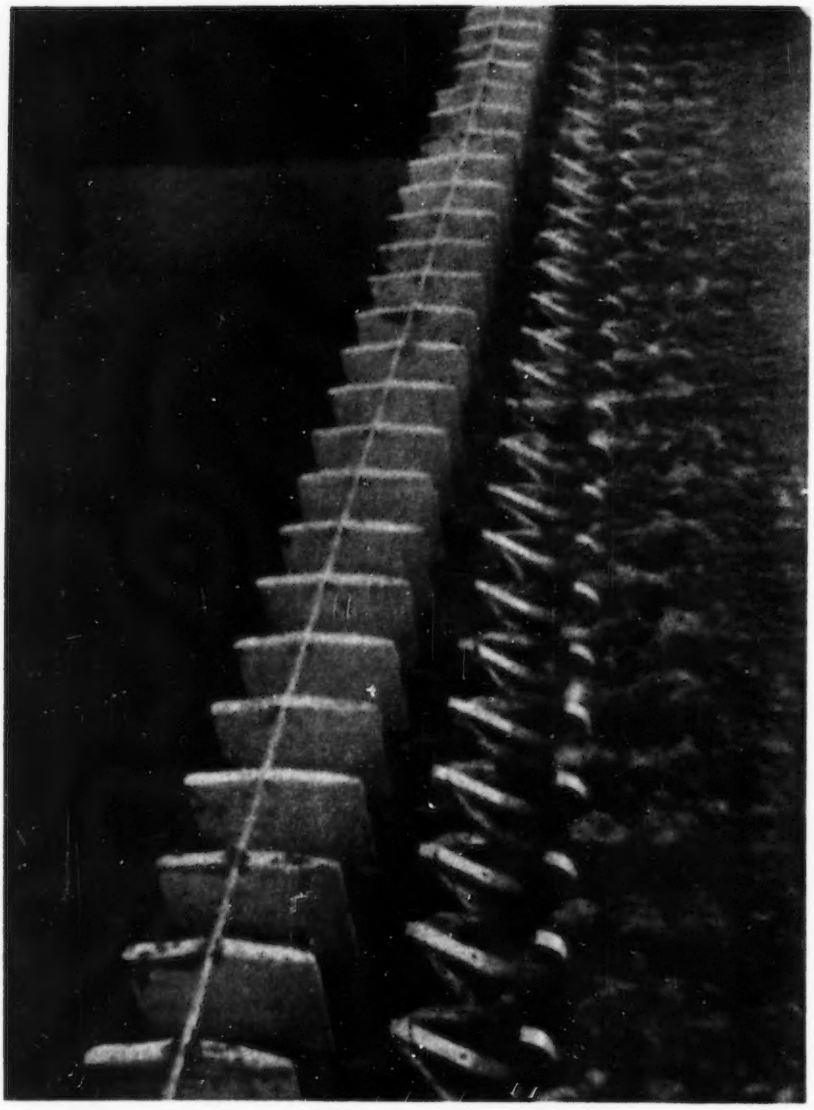

Fig. 1. Testing a velocity reducing device at the outdoor hydraulic laboratory near Lahore, Pakistan.

Fig. 2. Gate on Danube-Tisa Canal at junction with the Tisa River, Serbia, Yugoslavia.

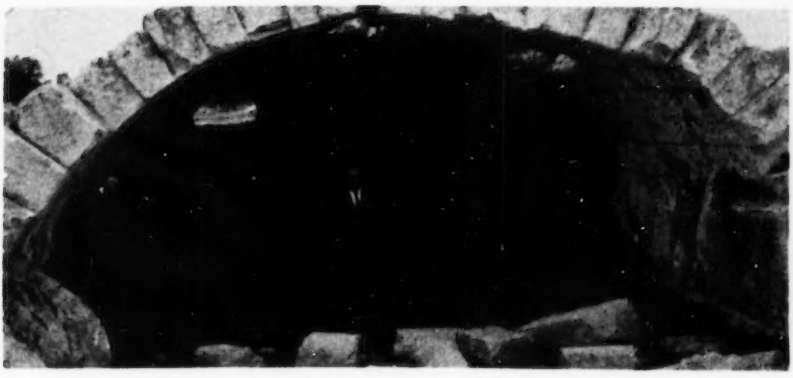

Fig. 3. Remnants of one of the water cisterns serving the ancient city of Cirene.

Fig. 4. Excess salts in a cultivated field on the Gangetic Plain under annual rainfall of 55 inches.

Fig. 5. Landscape pattern in the hilly country near Nova Sad, Serbia, Yugoslavia.